




IACTEC – Instituto de Astrofísica de Canarias

## ALISIO-1

### STATEMENT OF WORK AND TECHNICAL SPECIFICATION FOR THE PROCUREMENT OF ALISIO-1 SATELLITE, LIC-21-034

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## 1. Related Documents

### 1.1 Applicable Documents


Applicable documents are considered to be part of this document, to the extent specified in this document.

See the master index provided along with the tender pack.

### 1.2 Reference Documents


Reference documents are not part of this document but should be consulted for important additional information. These documents are the ECSS standards applicable to space projects, and the most relevant ones for this contract can be seen in the following table.

ID	Code	Document	Issue
RD.1	ECSS-Q-ST-20C	Quality assurance	-
RD.2	ECSS-Q-ST-20-08C	Storage, handling and transportation	-
RD.3	ECSS-Q-ST-60C	EEE components	-
RD.4	ECSS-Q-ST-70-01C	Cleanliness and contamination control	-
RD.5	ECSS-Q-ST-80C	Software product assurance	-
RD.6	ECSS-U-AS-10C	Space debris mitigation requirements	-
RD.7	ECSS-E-ST-10-02C	Verification	-
RD.8	ECSS-E-ST-10-03C	Testing	-
RD.9	ECSS-E-ST-20-C	Electrical and electronic	-
RD.10	ECSS-E-ST-31C	Thermal control general requirements	-
RD.11	ECSS-E-ST-32C	Structural general requirements	-
RD.12	ECSS-E-ST-40C	Software	-
RD.13	ECSS-E-ST-50C	Communications	-
RD.14	ECSS-E-ST-70C	Ground systems and operations	-
RD.15	CDS	Cubesat Design Specification	13
RD.16	ECSS-M-ST-10C	Project Planning and Implementation	-
RD.17	ECSS-Q-ST-10C	Product Assurance Management	-


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## 2. List of Abbreviations and Acronyms

ADCS	Attitude Determination and Control System
AIV	Assembly, Integration and Verification
ALISIO	Advanced Land Imaging Satellite for Infrared Observations
AOP	Average Orbit Power
AR	Acceptance Review
CCSDS	Consultative Committee for Space Data Systems
CDS	Cubesat Design Specification
CDR	Critical Design Review
CRR	Commissioning Result Review
CVCM	Collected Volatile Condensable Material
DRAGO	Demonstrator for Remote Analysis of Ground Observations
ECSS	European Coordination for Space Standardization
EEE	Electrical and Electronic Equipment
EOL	End of Life
EPS	Electronic Power System
ESA	European Space Agency
FDIR	Fault Detection, Isolation and Recovery
FM	Flight Model
FRR	Flight Readiness Review
FWHM	Full Width Half Maximum
GNSS	Global Navigation Satellite System
GS	Ground Station
GSD	Ground Sampling Distance
IAC	Instituto de Astrofísica de Canarias
ICD	Interface Control Document
KO	Kick-Off
LEO	Low Earth Orbit
LEOP	Launch and Early Operation Phase
MDR	Mission Definition Review
O3K	Orthogonal On-Off Keying
OBDH	On Board Data Handling

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OOK-NRZ	Non-return-to-Zero On-Off Keying
PDR	Preliminary Design Review
PIU	Payload Interface Unit
PM	Project Manager
PPT	Pliego de Prescripciones Técnicas
QM	Qualification Model
RML	Recovered Mass Loss
SAA	South Atlantic Anomaly
SEE	Single Event Effects
SoW	Statement of Work
SPF	Single Point Failures
SWIR	Short Wave Infrared
TRR	Test Readiness Review
TTC	Telemetry Tracking and Command
TVAC	Thermal Vacuum
UART	Universal Asynchronous Receiver-Transmitter
UHF	Ultra-High Frequency
VHF	Very-High Frequency

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### 3. Introduction

#### 3.1 Background

Between 2018 and 2020, the instrument DRAGO was developed within IACTEC-Space. This instrument is a SWIR camera that is able to acquire images in the range between 1 micron and 1.7 microns. The instrument was finally integrated onboard the satellite ION mk-02 from D-Orbit, and it is currently in operations in a LEO orbit.

A new version of DRAGO, DRAGO-2, will be available at the end of 2021. This new version will include an improved optical subsystem that will reduce the GSD of DRAGO to about ~50 m.


The IAC aims to embark this new payload in the mission ALISIO-1. This mission will put in orbit a 6U+ satellite, called ALISIO-1, in 2023. This satellite will be the first one owned by the IAC, being its main payload, DRAGO-2, fully developed at IAC. The main objective of this mission will be to take medium-high resolution SWIR images that will provide valuable information for environmental related studies, such as desertification, oil spills and wildfires impact.

Once DRAGO-2 is ready, it is necessary to integrate it in a platform to conform the satellite ALISIO-1. This platform is the responsible of providing the electric power to the payload, a communication link with the Earth and the capability of controlling its orientation for pointing to specific targets. Finally, the satellite shall be placed in a low Earth orbit (LEO) for its operation.

It is expected from the bidders to provide and commission the satellite ALISIO-1, fulfilling the technical specifications defined in section 4 and following the statement of work defined in section 5.

#### 3.2 Scope

This document is part of the documentation package delivered for the tender of the ALISIO-1 mission. It includes the technical specifications and the statement of work applicable for the procurement of the satellite ALISIO-1 and its commissioning. This includes the design and manufacture of a 6U+ platform, the manufacture or acquisition of a payload for performing optical communications, the integration of the two payloads within the platform (DRAGO-2 and the optical communications payload), the verification of the complete satellite before launch, its delivery to the launch site and the accomplishment of the commissioning activities required before the start of routine operations.

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Section 4 contains the technical requirement specifications for the supply of the platform that is the main component of the ALISIO-1 satellite. It includes the interface requirements to allow the successful integration of DRAGO-2. It also includes indicative technical requirements of the optical communications payload that must be integrated within the satellite. The interface requirements between this optical module and the platform are not included in this specification, since their definition is under the responsibility of the supplier. These specifications will be used by the bidders during the tendering phase to define a proposal to design, manufacture, assemble, verify, deliver and commission the ALISIO-1 satellite.

Section 5 contains the Statement of work proposed for the delivery of the ALISIO-1 satellite. It includes a definition of the phases associated to the project development, the main milestones foreseen within these phases, the deliverables required at each milestone and the proposed reviews to monitor and control the evolution of the project.

The contractor will be the Instituto de Astrofísica de Canarias (IAC), being the IACTEC-Space team the responsible of the evaluation and supervision of the activities required in this document.



## 4. Technical requirements

### 4.1 Requirements identification

The requirements within this document are identified with a requirement tag following the format [R-N], where N is a unique number.

Requirements are grouped into categories: “essential”, “optimal” or “desirable”. The “essential” category is the minimum acceptable value of the requirement. The “optimal” category is the value that will be adopted if feasible. The “desirable” category is the value that should be adopted if feasible, but that should not drive cost and/or time to product completion. An essential requirement is defined as a ‘must’, an optimal requirement is defined as a ‘should’ and a desirable requirement is defined as a ‘could’.

In addition, each requirement carries a verification tag stating the minimum verification method(s) applicable for that requirement verification (D: Design Review; A: Analysis; I: Inspection; T: Test).

### 4.2 ALISIO-1 satellite requirements


#### 4.2.1 Functional requirements

Req ID	Requirement	Comments	Verification
R-1001	The platform must generate electric power		T
R-1002	The platform must provide electric power to the payloads		T
R-1003	The platform power supplies must include overcurrent protections		T
R-1004	The platform must monitor the status of the batteries	Ensure that the batteries are never fully discharged and keep enough power for restarting the satellite and performing safe mode operations	A
R-1005	The platform must be able to communicate with the Earth using the S-band		T
R-1006	The platform should be able to communicate with the Earth using an UHF-VHF antenna		T
R-1007	The platform communication system should provide reconfiguration capabilities in order to admit several data link protocols	x.25, CCSDS	T
R-1008	The platform must be able to interchange information (TC, housekeeping TM and science data) with the payloads	According to [AD.3] for DRAGO-2 communications	T

R-1009	The platform must integrate an optical communications system as a payload	According to the indicative requirements defined in section 4.3	D
R-1010	The optical communication payload must be able to establish an optical link with an optical GS of 100 cm aperture	From LEO	D
R-1011	The platform must include an embedded software that provides housekeeping and control functions		T
R-1012	The platform should provide remote access to the debug console of DRAGO-2 by means of a dedicated UART		T
R-1013	The platform must provide an ADCS system to provide pointing capabilities to the satellite		D
R-1014	The platform should ensure an ambient temperature between -10°C and +40°C for the DRAGO-2 payload when passing over the ROI	ROI is located in latitudes between -50° and +50° during sun light (not eclipse)	D
R-1015	The platform should include protection features against radiation effects on EEE components	i.e. Single Event Effects (SEE)	D

#### 4.2.2 Performance requirements

Req ID	Performance parameter	Perform. Req.	Unit	Comments	Verification
R-1016	Regulated voltage power supply	5	V	@ min 2A	T
R-1017	Peak power supply	10	W	Peak power during the switch-on of DRAGO-2	T
R-1018	AOP at EOL	>1,8	W		T
R-1019	Output Ripple of regulated power supply	<50	mVpp	Peak to Peak	T
R-1020	Data rate between the platform and DRAGO-2	>1	Mbps		T
R-1021	Data storage capacity	>256	MB	Data storage dedicated to the payloads	D
R-1022	Downlink rate	>1	Mbps		T
R-1023	Uplink rate	>19,2	Kbps		T
R-1024	Absolute pointing knowledge	<0.1	°	3 sigma values	T

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R-1025	Absolute pointing error	<0.5	°	3 sigma values	T
R-1026	Duty cycle	>10	%	Approximately 10 minutes per orbit, using the payloads sequentially and in different orbits	T

#### 4.2.3 External interface requirements

Req ID	Requirement	Comments	Verification
R-1027	The platform must conform to DRAGO-2 ICD	According to [AD.2]. A final ICD will be prepared during phases B and C according to the SoW	T
R-1028	The platform should provide a payload controller unit		D
R-1029	The payload controller unit should be able to manage the payloads through scripts		T
R-1030	The satellite ALISIO-1 should conform with the CDS rev.13, rev.13	According to [RD.15] and considering the information provided in DRAGO-2 ICD [AD.3]	D
R-1031	The satellite should provide an external surface of at least 50x50 mm where a label can be added without interfering the normal operation of the satellite	i.e. a 50x50 mm surface free of solar panels, antennas, etc.	I

#### 4.2.4 Physical requirements


Req ID	Requirement	Comments	Verification
R-1032	The platform must be a 6U+ satellite with free volume for the integration of the payload DRAGO-2 in the -Z face of the satellite pointing to Earth	According to [AD. 3]	D
R-1033	The optical communications payload must be integrated in the -Z face of the satellite, beside DRAGO-2	The optical communications payload must be pointing in the same direction than DRAGO-2 in order to reduce the quantity of maneuvers in orbit	D
R-1034	The platform should be constructed using low outgassing materials	RML < 1.0% CVCM < 0.1%	D
R-1035	The optical communications payload should be constructed using low outgassing materials	RML < 1.0% CVCM < 0.1%	D

#### 4.2.5 Operational requirements

Req ID	Requirement	Comments	Verification
R-1036	The satellite must be able to perform TTC&data downlink daily		T
R-1037	The satellite must be able to track a ground station for at least 3.5 minutes	Tracking means having the ground station within a circumference of 12.5 km of diameter, where the center is the Z axis of the satellite.	
R-1038	The satellite must provide a safe operation mode	Apart from the nominal operation mode	T
R-1039	The satellite should provide a tracking operation mode	Used for the tracking of ground stations during downlink/uplink operations and during optical communication link tests	T
R-1040	The supplier must provide an operational manual in order to allow the transfer of operations to a third party	The manual must include nominal and contingency procedures in enough detail to allow a third party to operate the satellite ALISIO-1	D

#### 4.2.6 Environmental requirements

Req ID	Requirement	Comments	Verification
R-1041	The satellite must be fully functional in a LEO orbit	Orbit characteristics: - Sun synchronous - 500-600 km height - LTAN 10:00-12:00 am	D
R-1042	The satellite must stand the vibrations expected during the launch	Minimum sine+quasistatic qualification test levels: - 5 Hz → 2.5 g - 21 Hz → 2.5 g - 25 Hz → 15 g - 30 Hz → 15 g - 35 Hz → 3 g - 110 Hz → 3 g - 125 Hz → 0.25 g Sweep rate 2 Oct/min  Minimum random vibration qualification test levels:	T

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		- 20 Hz → 0.0563 g <sup>2</sup> /Hz - 50 Hz → 0.16 g <sup>2</sup> /Hz - 800 Hz → 0.16 g <sup>2</sup> /Hz - 2 kHz → 0.026 g <sup>2</sup> /Hz Duration: 120 seconds Grms: 14.16 g	
R-1043	The satellite must stand the shocks expected during the launch	Minimum SRS test levels: - 30 Hz → 5 g - 1000 Hz → 1500 g - 10000 Hz → 1500 g	T
R-1044	The satellite must be able to operate in vacuum	Vacuum level <math>10^{-5}</math> mbar	T
R-1045	The satellite must be operable in a temperature range between -20°C and +50°C		T
R-1046	The satellite must survive within a temperature range between -30°C and +60°C		T
R-1047	The satellite must survive and operate successfully in the radiation environment expected at LEO	Excluding the SAA, where the satellite will not be necessarily operative	D

#### 4.2.7 Logistics support requirements

Req ID	Requirement	Comments	Verification
R-1048	The satellite ALISIO-1 (i.e. platform plus integrated payloads) must be packaged prior to the delivery to the launch site		D
R-1049	The packaging of ALISIO-1 must ensure a safe transportation		D
R-1050	The supplier must be responsible, in cost and risk, for the transport of the ALISIO-1 satellite from its facilities to the launch site		D
R-1051	The supplier must be responsible of the frequency filling of the satellite	Required for the commissioning phase of the satellite	D

#### 4.2.8 Quality assurance requirements

Req ID	Requirement	Comments	Verification
R-1052	The platform supplier should conform with the ECSS product assurance guidelines	According to [RD.17]	D
R-1053	The supplier should document the planning of the manufacturing, assembly and integration stages and inspections in the manufacturing plan or flow chart for the		D

	product, including the sequence of operations, inspections and tests		
R-1054	The planning should include the identification of the mandatory inspection points together with the reference to the procedures by which the various activities are performed and the required cleanliness levels and temperature and humidity requirements of the facilities		D
R-1054	The supplier should implement a non-conformance control procedure		I
R-1055	The minimum TRL of the platform critical components must be 7 or higher	The following components are considered critical: <ul style="list-style-type: none"> <li>- OBDH unit.</li> <li>- EPS.</li> <li>- Solar Panels.</li> <li>- Batteries</li> <li>- TTC.</li> <li>- ADCS.</li> <li>- GNSS.</li> <li>- Structure.</li> <li>- PIU.</li> </ul>	A
R-1057	The minimum TRL of the platform critical components should be 8 or higher	The following components are considered critical: <ul style="list-style-type: none"> <li>- OBDH unit.</li> <li>- EPS.</li> <li>- Solar Panels.</li> <li>- Batteries</li> <li>- TTC.</li> <li>- ADCS.</li> <li>- GNSS.</li> <li>- Structure.</li> <li>- PIU.</li> </ul>	A

#### 4.2.9 Reliability and maintainability requirements

Req ID	Requirement	Comments	Verification
R-1058	The platform must be designed to be operable in a LEO orbit for at least one year		D
R-1059	The platform should be designed to be operable in a LEO orbit for at least three years		D

R-1060	The platform should include an embedded software that provides FDIR functionalities that allow a recovery against faulty situations		T
R-1061	Single Point Failures (SPF) should be avoided wherever possible		D
R-1062	The supplier must be responsible for the delivery of any software/firmware package required for the maintenance of the platform once in orbit	Applicable through the first year of operation as a minimum	D
R-1063	The platform software must be updatable once in orbit using patches		T

#### 4.2.10 Development and verification requirements

Req ID	Requirement	Comments	Verification
R-1064	The supplier must be responsible for providing the complete AIV Plan for the platform and the optical communication payload	DRAGO-2 AIV Plan shall be delivered by IAC	D
R-1065	The supplier must be responsible of performing the verification of the complete satellite regarding functionality, performance and environmental testing	IAC shall support all the verification activities related with DRAGO-2 payload	D
R-1066	The implementation of the verification program should be controlled and monitored by formal control and review boards	The minimum required reviews are defined in the SoW	D
R-1067	The platform supplier should provide a qualification model (QM) of the platform to ease the integration between the platform and the payload DRAGO-II	To be delivered not later than phase C according to the SoW	D
R-1068	The platform QM must be representative of the structure of the platform Flight Model (FM)	It will be used during the mechanical and TVAC tests of DRAGO-2 (vibration and shock)	D
R-1069	The electrical interface of the platform QM must be representative of the electrical interface of the platform FM	It will be used to check the electrical integration between DRAGO-2 and the platform	D
R-1070	The data interface of the platform QM must be representative of the data interface of the platform FM	It will be used to check the data transmission between DRAGO-2 and the platform	D
R-1071	The payload controller of the platform QM must be representative of the payload controller of the platform FM	It will be used to develop the software interface between DRAGO-2 and the platform	D

### 4.3 Optical communication payload requirements

What follows is a set of Physical Layer characteristics of the free-space optical communications system to be used in this space mission, specifically space-to-ground and ground-to-space links through an atmospheric channel.

The requirements that follow are indicative and they describe the functionality of compatible laser communication equipment using Orthogonal On-Off Keying (OOK), mainly for use with, but not limited to, high-speed optical direct-to-Earth telemetry data downlinks. At the sending end, a binary vector is received from the Coding and Synchronization sublayer, not specified here as a requirement, indicating a sequence of slots in which light pulses are to be present (1) or absent (0). The physical characteristics of these transmitted pulses are described below. At the receiver, the Physical Layer demodulates the data and delivers statistics to the Coding and Synchronization sublayer for its use in decoding.

All requirements described here are aligned with the CCSDS standard 141.0 (OPTICAL COMMUNICATIONS PHYSICAL LAYER). The Coding and Synchronization sublayer is left open on purpose to maximise the options available to the bidder. However, the use of the corresponding CCSDS standard will be strongly appreciated.

The supplier is requested to analyse these requirements and propose during the tendering phase an optical communications payload that can be used onboard the satellite ALISIO-1 to establish space-to-Earth optical communication links with an optical GS of 100 cm aperture.

#### 4.3.1 Functional requirements

Req ID	Requirement	Comments	Verification
R-2001	The wavelength used for the communications downlink should be $1550.116 \pm 0.08$ nm		T
R-2002	(Spill-over) The laser should transmit 95% of its energy within $\pm 20$ GHz of its center frequency		D
R-2003	The modulation scheme should be Non-return-to-Zero On-Off Keying (OOK-NRZ)		D
R-2004	The possible values for slot width will be, in ns, 0.1 / 0.2 / 0.4 / 0.8 / 1.6 / 3.2 / 6.4 / 12.8 / 25.6 / 51.2 / 102.4 / 204.8 / 409.6 / 819.2		D



#### 4.3.2 Performance requirements

Req ID	Performance parameter	Perform. Req.	Unit	Comments	Verification
R-2005	Minimum downlink beam power	2	W		T
R-2006	Maximum downlink beam divergence	300	μrad		D
R-2007	Pointing performance	50	μrad	1 sigma	D
R-2008	Tolerance of the transmitter center frequency	+/-10	GHz		D
R-2009	Maximum modulated laser linewidth, measured at FWHM	10	GHz		D
R-2010	Timing jitter respect to the slot width	10	%		D
R-2011	Minimum extinction ratio (mean ON to mean OFF levels)	10	dB		D

#### 4.3.3 Beacon signal requirements

Req ID	Performance parameter	Perform. Req.	Unit	Comments	Verification
R-2012	Wavelength lower limit	1063.82	nm	281.807 THz	T
R-2013	Wavelength upper limit	1064.82	nm	281.543 THz	T
R-2014	Center frequency tolerance	±132.3	GHz		D
R-2015	Laser line width, FWHM	±66	GHz		D
R-2016	Energy transmitted by laser within ±50 GHz of its center frequency	95	%		D
R-2017	Maximum pulse repetition rate	20	kHz	If modulated	D

## 5. Statement of work

### 5.1 Project phases, milestones and associated deliverables

*R-3001:* The development of the ALISIO-1 satellite should follow the approach defined by the ECSS in [RD. 16].

This standard divides the development of a space project in seven phases, starting from phase 0 (Mission analysis) and ending with phase F (Disposal).

*R-3002:* The first batch of this tender must cover from phase A to phase E (not routine operations, only commissioning phase).

A summary of the phases, their associated milestones and deliverables can be seen in the following table. In the following sections, the different phases are described in more detail, including their milestones and associated deliverables.


Phase	Review	Milestone	Deliverables
A	KO	M1.0	N/A
	MDR	M1.1	D1.1: Mission Design Report
B	PDR	M1.2	D1.2: Preliminary Design Report
			D1.3: Preliminary ALISIO-1 ICD
			D1.4: Platform qualification model (if applicable, see R1067)
C	CDR	M1.3	D1.5: Detailed Design Report
			D1.6: ALISIO-1 ICD
			D1.7: AIV plan
D	TRR	M1.4	D1.8: Functional, performance and environmental test specification
	AR	M1.5	D1.9: Functional, performance and environmental test report
			D1.10: As built configuration
			D1.11: Satellite operational manual
E	FRR	M1.6	D1.12: Satellite ALISIO-1
			D1.13: Flight readiness report
			D1.14: Commissioning phase specification
	CRR	M1.7	D1.15: Radiofrequency filling
			D1.16: Commissioning phase report

#### 5.1.1 Phase A

*R-3003:* The project must start with the kick-off (KO) meeting.

*R-3004:* The KO must be conducted to evaluate the following, as a minimum:

- to formalize the commencement of the project and initiate the phase A,

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- to ensure that a common understanding is in place in relation to the execution of the Contract,
- to clarify and provide more information on any matter that may need additional attention since the bidding phase,
- to agree on more specific closure dates for all the pending points related to the documentation,
- to ensure that a common understanding is in place in relation to the documentation deliverables content and format.

*R-3005:* Within one month after the signature of the contract, the supplier must perform, together with the IAC, a further analysis of the mission requirements defined in section 4.

*R-3006:* The supplier must elaborate a Mission Design Report (Deliverable D1.1). This document will include, as a minimum:

- a description of the 6U+ platform proposed at system level,
- a description of the optical communications module proposed and its integration in the platform proposed,
- a concept proposal for the integration of DRAGO-2 within the platform,
- a description of the expected performance of the platform in a sun-synchronous LEO orbit,
- a first iteration analysis regarding the compliance of the mission requirements.

*R-3007:* Phase A must end with the Mission Definition Review (MDR) and the closing of any actions that could arise during phase A.

*R-3008:* The deliverable D1.1 must be sent to the IAC at least with one week of anticipation to the MDR for its review.


### 5.1.2 Phase B

*R-3009:* Phase B must start after the accomplishment of the MDR.

*R-3010:* During phase B, the supplier must elaborate a Preliminary Design Report (Deliverable D1.2).

*R-3011:* The supplier must include in the Preliminary Design Report, as a minimum:

- a description of the platform proposed up to a subsystem level.
- a description of the integration of both payloads, DRAGO-2 and the optical communications module,

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- an assessment of the compliance of the requirements established in section 4 of this document.

*R-3012:* The supplier must elaborate a Preliminary ICD of ALISIO-1 (Deliverable D1.3).

*R-3013:* In order to ease the integration of DRAGO-2, the supplier must work together with the IAC in the definition of this ICD in those aspects related to the integration of DRAGO-2.

It is important to note that, although not desirable, DRAGO-2 could accept minor modifications in the external case in order to fit it to the mechanical interface of the platform.

*R-3014:* The supplier must take the full responsibility of integrating the optical communications payload with the platform.

*R-3015:* The Preliminary ICD must include information relative to the radiofrequency interface of the satellite, so this information can be used by a third party to complete the tasks associated to the radiofrequency filling of the satellite. So, the information included in the ICD must be sufficient for completing the satellite frequency filling on the satellite side.

*R-3016:* During phase B, the supplier must provide to the IAC a qualification model of the satellite representative of the mechanical, electrical and data interfaces of the proposed platform (Delivery D1.4). This requirement only applies if the qualification model was offered during the tendering phase.

*R-3017:* The supplier must cover the expenses derived from the delivery of the qualification model indicated in R-3016.

*R-3018:* Phase B must end with the Preliminary Design Review and the closing of any actions that could arise during phase B.


*R-3019:* The supplier must send to the IAC the deliverables D1.2, D1.3 and D1.4 at least one week prior to the conduction of the PDR for their review.

### 5.1.3 Phase C

*R-3020:* Phase C must start after the accomplishment of the PDR.

*R-3021:* During phase C, the supplier must elaborate a Detailed Design Report (Deliverable D1.5).

*R-3022:* The supplier must include in the Detailed Design Report, as a minimum:

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- a description of the platform and its subsystems to a level of detail that allows the acquisition of all the components required for its manufacturing,
- a detailed description of the integration of both payloads, DRAGO-2 and the optical communications module,
- a detailed assessment of the compliance of the requirements established in section 4 of this document,
- all the information of the satellite ALISIO-1 required for completing the compliance and regulatory tasks required for the launch and operation of the satellite (i.e. satellite insurance, satellite registration and radiofrequency filling).

*R-3023:* The supplier must complete the ALISIO-1 ICD during this phase (Deliverable D1.6).

*R-3024:* The AIV plan must be completed during phase C (Deliverable D1.7).

*R-3025:* The AIV plan must include the information related to the functional and performance testing of the satellite ALISIO-1.

*R-3026:* The supplier must be fully responsible of the optical communication module integration and testing plan definition.

*R-3027:* Phase C must end with the accomplishment of the Critical Design Review (CDR) and the closing of any actions that could arise during phase C.

*R-3027:* All the deliverables associated to this phase must be sent to the IAC at least one week prior to the conduction of the meeting for their review.

#### **5.1.4 Phase D**


*R-3029:* Phase D must start after the accomplishment of the CDR.

*R-3030:* Once DRAGO-2 is assembled, the supplier must manage its pickup from IAC facilities, covering any expenses derived from the delivery<sup>1</sup>.

*R-3031:* During phase D, and at least one week prior to the Test Readiness Review (TRR), the supplier must deliver to the IAC the Functional, Performance and Environmental test specification (Deliverable D1.8).

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<sup>1</sup> If a qualification model of the platform has been delivered during phase B, the payload DRAGO-2 shall be assembled with the qualification model in order to ease the integration of DRAGO-2 in the platform flight model.

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*R-3032:* The supplier must define the rest of the specification, related to the platform and the optical communications payload functionality and performance.

*R-3033:* The Functional, Performance and Environmental test must include, as a minimum:

- a detailed description of the Equipment Under Test (EUT),
- a description of the test fixtures used during the tests,
- a description of the functions to be tested, together with the expected performance of the EUT,
- a step by step procedure of the tests to be completed (functional, performance and environmental),
- a reduced version of the functional and performance tests that can be used for when a quick check of the EUT is necessary (i.e. between each environmental test and prior to the integration of the satellite within the deployer).

*R-3034:* The Test Readiness Review (TRR) must be held once the PFM of the satellite ALISIO-1 has been assembled, prior to the testing phase of the satellite.

*R-3035:* After the pass of the TRR, the supplier must conduct all the verification activities described in the Functional, Performance and Environmental test specification.

*R-3036:* A team of IAC engineers should assist and support, if possible, during this phase, especially during the conduction of the verification activities of the payload DRAGO-2.

*R-3037:* The supplier must prepare a report gathering all the information obtained during the integration and verification phase of the satellite ALISIO-1 (Deliverable D1.9).


*R-3038:* This report must be used, together with the Detailed Design Report, to demonstrate the compliance with all the requirements defined in section 4 of this document.

*R-3039:* The supplier must prepare, at the end of this phase, a report showing the “As built configuration” of the satellite ALISIO-1 (Deliverable D1.10).

*R-3040:* Before the end of phase D, the supplier must provide an operational manual of the satellite (Deliverable D1.11), with enough information so a third party can operate the satellite.

*R-3041:* The ALISIO-1 operation manual must include, as a minimum:

- a description of the satellite,
- a description of the operational environmental limits of the satellite,

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- a description of the survival environmental limits of the satellite,
- a detailed description of the functionalities and performance of the satellite,
- a detailed description of the functionalities and performance of the satellite in contingency situations,
- a detailed list of the telecommands required for the operation of the satellite,
- a detailed description of the telemetry generated by the satellite.

*R-3042:* The supplier must provide the satellite ALISIO-1 (D1.12).

*R-3043:* Phase D must end with the Acceptance Review (AR), when all the actions that could arise during phase D are closed and the satellite ALISIO-1 is finally accepted.

*R-3044:* The deliverables D1.9, D1.10 and D1.11 must be sent to the IAC at least one week prior to the conduction of the meeting for their review.

#### 5.1.5 Phase E

*R-3045:* Phase E must start after the accomplishment of the AR.

*R-3046:* The supplier must prepare the satellite ALISIO-1 for the delivery.

*R-3047:* The supplier must package the satellite ALISIO-1 attending to the requirements defined in section 4.2.7 of this document in order to ensure a safe transport of the satellite to the launch facilities.

*R-3048:* The supplier must be responsible of the timely delivery of the satellite to the launch facilities.


*R-3049:* If the supplier of batch 1 and batch 2 are different, the supplier of the first batch must be responsible of the coordination between both parties for the timely delivery of the satellite.

*R-3050:* The supplier must be responsible of performing the last checks of the satellite ALISIO-1 before its integration in the deployer.

*R-3051:* These last checks must include, as a minimum:

- a reduced functional and performance test of the satellite.
- the charging of the batteries.

*R-3052:* The results of these checks and any incidences that could appear during the integration of the satellite within the deployer must be gathered in the Flight Readiness Report (Deliverable D1.13).

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*R-3053:* The supplier must define a specification for the activities to be performed during the commissioning phase (Deliverable D1.14).

*R-3054:* The supplier must complete the radiofrequency filling of the satellite for its operation during the commissioning phase (Deliverable D1.15).

*R-3055:* The commissioning phase specification must include, as a minimum:

- all the tests to be completed during the LEOP and commissioning phases, presented in a sequential manner,
- the expected results of every test, together with any foreseen issues that could occur and their contingency measures,
- a list of the required resources for its implementation,
- a schedule for the LEP and commissioning phases,
- a definition of the ground segment to be used during the used during the LEOP and the commissioning phases.

*R-3056:* The Flight Readiness Review (FRR) must be held once the satellite is integrated in the deployer and before its launch.

*R-3057:* Deliverables D1.13, D1.14 and D1.15 must be sent to IAC at least one week prior to the FRR for their review.


*R-3058:* After the launch of the satellite, the supplier must be responsible of conducting the commissioning phase.

*R-3059:* During this phase, the supplier must be responsible of:

- managing the ground segment required for completing the LEOP and the commissioning phase,
- defining the telecommands to be sent to the satellite according to the commissioning phase specification,
- interpreting the telemetry received from the satellite, evaluating if the satellite performance is within expected boundaries,
- evaluating any contingency situation that could occur, defining the contingency operations to be performed,
- delivering the imagery data to the IAC in a timely manner for its analysis.

*R-3060:* All the information gathered during the commissioning phase must be reflected in the commissioning phase report (Deliverable D1.16), including a final assessment regarding the readiness of the satellite ALISIO-1 for starting the routine operations phase.



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*R-3061:* Phase E must finish after the accomplishment of the Commissioning Results Review (CRR), and the closing of any actions that could arise during phase E.

*R-3062:* All the deliverables associated to this phase must be sent to the IAC at least one week prior to the conduction of the meeting for their review.

*R-3063:* The supplier of batch 1 must provide support for the operational phase of DRAGO for at least six months after the commissioning is completed.

*R-3064:* The supplier support during the operational phase must include, at least:

- the maintenance of the platform software, if any issue is discovered during the routine operations,
- the analysis of platform malfunctions detected during the routine operations,
- the analysis of contingency situations,
- the definition of required operations for restating routine operations.

## 5.2 Project and product assurance management

*R-3065:* In order to ensure the delivery of the satellite ALISIO-1 in time and compliant with all the requirements established in section 4, the supplier should follow:

- the ECSS standards for the project planning and implementation [RD.16],
- the ECSS standards for the product assurance of space projects [RD.17].

The following sections highlight some of the requirements established in these two standards that are considered critical to the success of the project.

### 5.2.1 Project management

The following project management tasks are considered critical for ensuring a fluid interface with the IAC and the delivery of the satellite in the proposed time schedule:

- Definition of the project management organization in such a way that adequate resources are allocated to the project to ensure timely completion of the contract.
- Nomination of a Project Manager (PM) with a Project Team under its authority.
- Execution of the following meetings in a timely manner according to the established milestones, with agreed minutes and actions signed by all participants after the meeting:
  - MDR.
  - PDR.
  - CDR.
  - TRR.

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- AR.
- FRR.
- CRR.

- Development and maintenance of a schedule that takes into account the activities to be performed, the resources to be allocated, the key milestones of the project and the critical path.

### 5.2.2 Product assurance management

The following product assurance tasks are considered critical for ensuring the delivery of a satellite compliant with the requirements:

- Nomination of a Product Assurance Manager reporting to the supplier's PM.
- Preparation, maintenance and implementation of a Product Assurance Plan.
- Identification of the satellite critical items.
- Definition and implementation of a critical items control program.
- Definition and implementation of a non-conformance control system.

### 5.3 IAC undertakings

The IAC shall support to the supplier in the development of the satellite ALISIO-1, more especially in those aspects related with the payload DRAGO-2. The following sections describe the tasks and deliverables where the implication of the IAC is foreseen.

#### 5.3.1 Services

The services to be provided by IAC to the ALISIO-1 Supplier are listed below:

Nº	Short description	Date
1	The IAC shall support to the supplier in the development of the Mission Design Report providing information related to the integration of the payload DRAGO-2	Phase A
2	The IAC shall support to the supplier in the development of the Preliminary Design Report providing information related to the integration of the payload DRAGO-2	Phase B
3	The IAC shall support to the supplier in the development of the ALISIO-1 ICD providing information related to the integration of the payload DRAGO-2	Phase B&C
4	The IAC shall support to the supplier in the development of the ALISIO-1 AIV plan providing information related to the integration and testing process of the payload DRAGO-2	Phase C&D

5	The IAC shall support to the supplier in the development of the ALISIO-1 test report providing information related to the test results of the payload DRAGO-2	Phase D
6	The IAC shall support to the supplier in the development of the ALISIO-1 as built configuration report providing information related to the as built configuration of the payload DRAGO-2	Phase D
7	The IAC shall support to the supplier in the development of the ALISIO-1 user manual providing information related to the operation of the payload DRAGO-2	Phase D
8	The IAC could support to the supplier during the last checks prior to the integration of the satellite ALISIO-1 in the deployer, especially regarding the verification of DRAGO-2 functionality and performance	Phase E
9	The IAC shall support to the supplier during the development of the commissioning phase specification in those tests related to the operation of DRAGO-2	Phase E
10	The IAC shall support to the supplier during the completion of the commissioning phase activities involving DRAGO-2	Phase E
11	The IAC could support to the supplier during the completion of the commissioning phase activities involving the optical communications module	Phase E

### 5.3.2 Hardware equipment

The hardware equipment to be provided by IAC to the ALISIO-1 supplier is listed below:

Nº	Short description	Date
1	DRAGO-2 (integrated within the platform qualification model, if it has been provided by the supplier during phase C)	Phase D

### 5.3.3 Software equipment


The software equipment to be provided by IAC to the ALISIO-1 supplier are listed below:

Nº	Short description	Date
1	DRAGO-2 operation scripts	Phase D

### 5.3.4 Mathematical models

The mathematical models to be provided by IAC to the ALISIO-1 supplier are listed below:

Nº	Short description	Date
1	DRAGO-2 step model	Phases A&B&C

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